SCIENCE

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We regret the delay in the issuing of *Science*, which is due to its taking longer to install The Science Press than was expected. Now that the new office is in working order we hope to make up for lost time.

CHARLES BONNET'S IDEA OF THE DEVELOPMENT OF THE CHICK.

Charles Bonnet, the distinguished naturalist, was born in Geneva in 1720 and died in 1793. He worked assiduously with microscope and lens and devised many new experiments on plants and animals. He was a friend of Haller's and stoutly maintained the latter's doctrine that all the vital functions could be reduced to two—sensibility and irritability. His first important work was the investigation of the life history of aphides, and his interpretation of parthenogenesis was a great triumph to the *ovists*. The process of development in his time was considered by many to be purely a proces of unfolding of a preformed germ which contained in miniature the future animal or plant. But the supporters of his idea were divided into two camps: the *animalculists* held that the miniature animal—the germ—was carried in the male seminal fluid to the proper matrix, where it found suitable nourishment and grew—*i.e.*, unfolded. The *ovists*, on the other hand, maintained that the germ existed in female and explained fecundation as a stimulus produced by the male fluid which furnished the first nourishment of the tiny germ. The fact, then, that a female aphide could produce offspring without coupling with a male seemed to give the ovists a convincing argument.

His works are interesting reading to-day, for he was not only a keen observer but a careful writer as well. To be sure, his facts are often meagre, and often the results of his or his contemporaries' observations were insufficient to base the broad generalities upon in which he delighted; yet within the knowledge that he had he argued well. Who knows but what the student of a hundred years hence may smile at Weissman's conclusions as we do at Bonnet's? In the following description of the development of the chick the reader should always keep this in mind and should as far as possible forget for the time much of the detail that has become known to us since improved microscopes and sections have been in use. The selection translated below may be found in his "Contemplation de la Nature" (tome iv., pt. 1, chap. x.), published in 1764:

LA GÉNÉRATION—LE POULET.

An egg not fecund has a yolk like an unfecund egg. The goodwives have known this all the time; and there is in this little fact, so well known, so little examined and so worthy of it, something which comes to throw a flood of light and has cleared away the shadows with which the great mystery of generation has been enveloped.

Give all your attention to this: you are going to put your finger on an important verity. A membrane invests the yolk internally, and this membrane, which is only the continuation of that which covers the small intestine of the chick, is common to the stomach, the pharynx, the mouth, to the skin and epidermis. Another membrane invests the yolk externally, and this membrane is only the continuation of that which covers the intestine: this unites with the mesentery and peritoneum. The arteries and veins which course through the yolk derive their origin from the mesenteric arteries and veins of the embryo. The blood which circulates in the yolk receives from the heart the impulse of its motion.

The yolk is, then, essentially, an appendage of the intestine of the embryo, and together they form an organic whole. Therefore, in earliest times, the chick is, to some degree, an animal with two bodies: the head, trunk and the extremities compose one of these bodies; the intestines and the yolk form the other. At the end of incubation the second body is pushed within the first, and the two make but the one.

But since the yolk exists in eggs which have not been fecundated, it follows necessarily that the germ is pre-existent to fecundation. This consequence stares one in the eyes: you come to see that the yolk is an essential part of the chick. You recognize the direct connection between the one and the other. The chick has not existed, then, without it. The membranes and vessels of it are only a continuation of those of itself. And how many other things there are which they have in common, which prove that they have never existed separately. The chick was, then, entirely in the egg before the fecundation. Then it owes not its origin to the liquor which the cock furnishes: it was defined *en petite* in the egg, prior to the commerce of the sexes. The germ, therefore, pertains exclusively to the female.

The evolution or development proceeds by nutrition; you have seen it. Nutrition supposes circulation; you have seen it also. Finally you have seen that the heart is the seat of circulation. If it does make a circulation in the germ before fecundation you will admit at least that it is not sufficient to perform the whole evolution which will render the germ visible, and which gives to all its parts, the form, proportions and arrangement which characterize the species.

The germ cannot achieve its development in an egg which has not been fecundated, and incubation will only hasten its corruption. Yet what does it lack in order to continue to grow? It has all the organs necessary to evolution. It has taken on itself a certain increase, for eggs increase in virgin pullets; their ovaries contain them in various sizes. The germ may grow, then. Why can it not develop completely? What secret force holds it back in the limits of invisibility?

Growth depends upon the impulse of the heart. A great growth depends upon a great impulse. The heart of the germ which is not fecundated lacks this impulse.

This demonstrates a certain resistance in the parts of the germ. In measure as it grows, this resistance in-

creases. Some parts resist more than others; the osseous parts more than the membranous.

The heart of the germ, then, needs a force proportioned to overcome this resistance. Its force is in its *irritability*, or in the power to contract when brought into contact with a liquid. Augment this irritability, and you augment its impulsive force.

Fecundation increases, without doubt, this force, and it alone can do that: since it is only by its intervention that the germ succeeds in freeing itself from the narrow limits which restrained it in its first stage.

The fecundating liquor is, then, a true stimulant, which, carried to the heart of the germ, excites it powerfully and communicates to it a new activity. This is what we call *conception*. Movement once impressed on this little prime mover is conserved by the unique energy of its admirable mechanism.

But it does not suffice that the heart acquire a force capable of overcoming the resistance of solids: the fluid which it sends them for nourishment must be proportioned to the marvelous fineness of the vessels. A blood such as ours would not circulate. The blood of the embryo at first is a whitish liquid; it turns yellow by degrees and finally becomes red. The impulse of the heart dilates the vessels more, and they admit larger particles, heterogeneous and colored.

The generative liquor is not, therefore, a simple stimulant: it is besides a nourishing fluid, appropriate to the extreme delicacy of the parts of the germ. It fulfilled already in the body of the fertilizing individual the functions of a nutritive fluid: it made the comb and spurs grow and gave strength to all parts. You recall the degeneracy of the capon, and how it differs from the cock. You might have many more proofs that the generating fluid is the first aliment of the germ.

Transported by the arteries to all the parts, it unites with them in a fixed manner, according to the proper nature of each. The chick is not slow to lose its form of tadpole. Wings, legs and feet proceed out of the long tail; everything comes out, fashions itself and arranges itself on a new model. The little animal, stretched out at first in an almost straight line, curves itself more and more. It invests itself more and more with muscles, tendons, bones and feathers, and in 18 or 20 days it is a perfect chick. B.

VACCINATION.

BY J. N. HALL, M.D., DENVER, COLO.

In view of the periodical crusades againt compulsory vaccination by certain enthusiasts opposed to the practice, I have thought that it might be of interest to the readers of *Science* to look at a few of the results to be deduced from recent statistics upon the subject. The reason why no thoroughly scientific study of the anti-vaccination side of the matter has been made would seem to lie in the fact that no scientific mind could view the situation in a judicial way without seing that all of the facts are upon one side, and that the one of the advocates of vaccination. With this prelude I will allow the facts to speak for themselves.

In 1874 the compulsory re-vaccination law became operative in Prussia. (See Dr. Sykes's "Public Health Problems," London). By its provisions, every infant must be re-vaccinated, and every scholar in public and private schools must be re-vaccinated at the age of twelve years. If we take the average number of deaths from small pox per 100,000 living in Prussia, we find that for the five years preceding the introduction of compulsory vaccination the number was 113+. Since the law went into effect, in but one year, up to 1883, has it reached 4 per 100,000. The average is much less. I have not at hand the figures since that time, for the whole population, but in the Prussian army, where all the conditions are under better control, the results are so much better that I will quote them. This is easily done, for with the exception of a single death in 1885, the name small pox has not appeared as a cause of death in the annual reports since the law went into effect. It should be borne in mind in this connection that Prussia is constantly exposed upon its Russian and Austrian borders to the disease.

As to the death rate in vaccinated and unvaccinated persons, we may quote the conclusions of Dr. Barry, in his report of the epidemic of 1887-8, in Sheffield, England. Without quoting the figures, it will suffice to present the statement that "the children vaccinated, had, as compared with the unvaccinated, a 20-fold immunity from attack, and a 480-fold security against death from small pox; the persons over ten years of age, once vaccinated, had a 5-fold immunity against attack, and a 51-fold security against death; and the twice vaccinated, a 31-fold immunity from attack, and a 640-fold security against death."

Inasmuch as the objections to vaccination on the ground that syphilis and leprosy may be transmitted may be completely done away with by the use of heifer-virus, we need not discuss the matter. There is, indeed, a certain element of danger in vaccination, as in every other thing of established value, but it is strange that in the face of such evidence as may be obtained from scores of reports of boards of health, medical departments of armies, etc., etc., there are still found those who deny the value of the most beneficent discovery ever made by man. There is good reason for hoping that we may soon be able to control in similar manner many other of the contagious diseases which have in the past made such havoc with our race.

—"The Political Economy of Natural Law," by Henry Wood, which appears from the press of Lee & Shepard, of Boston, is virtually an enlargement of a work published seven years ago under the title, "Natural Law in the Business World." The author's main thesis, that all industrial operations are governed by natural law, is of course nothing new, nor is his presentation of it more scientific than that of the regular economists, but less so; yet there is much in his book that may be useful if it reaches the right class of readers. Those who wish a thorough and scientific formulation of the known laws of economic life will prefer the regular treatises; but those who do not relish the hard study that such treatises require, and who like a more popular mode of treatment, will find in this work some useful lessons on the matters with which it deals. That the law of supply and demand cannot be set aside by artificial restraints, that combinations of laborers are often tyrannous, and combinations of capital tend to overreach themselves, and that socialism, if once established, would carry within itself the seeds of its own dissolution, though familiar truths to well-informed men, are not so widely known in the business world as they ought to be; and Mr. Wood's statement of them may attract readers who would never read the elaborate works of Mill and his successors. Mr. Wood takes extreme ground against legislation on business matters, but makes an exception in favor of the protective tariff, which seems to be a pet measure of his. On the whole, however, he is open-minded and fair, and his opinions in the main are such as the best economists will approve.